Urban Heat: The "Sixth Sense" lets you see it

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Abstract

The Urban Heat Island (UHI) effect is the phenomenon where urban areas retain heat because of their composition of low albedo materials such as asphalt and concrete. Past research using thermal spot sensors revealed that white and green roofs remain cooler than traditional black asphalt roofs. Also, we know the powerful cooling effects of urban vegetation, in the form of bioswales, at the street level. The objective of our study is to expand this research of the well known cooling effects of alternate roofs and urban vegetation by using thermal infrared cameras, while learning the potential of this technology in the study of urban climate. We used a FLIR T650SC thermal camera to gather data on the roofscape and streetscape. This research confirmed what we already knew about white roofs, green roofs, and bioswales. However, the infrared camera captures the entire thermal scene, rather than a mere point like prior data collection. The immensity of the data coupled with more efficient data processing allows us to learn more about the thermal landscape than prior research methods. The new technology enhances our ability to understand urban climate and inform policymakers on adaptation strategies to climate change in New York City and beyond.

Introduction

- One **billion** square feet of mostly black roofing in New York City.
- Black roofing enhances the **Urban Heat Island** effect where heat gets trapped because of its composition of low albedo materials.
- Increase in frequency and severity of **heat waves** expected with change in climate.
- By 2050, 66% of people are expected to live in urban areas (UN 2014).
- Green and white roofs offer adaptation and mitigation to the changing climate.
- Installing a **green roof** can save up to 10% on energy costs in the summer (Synnefa et al. 2008)
- **Bioswales** also help in reducing the Urban Heat Island effect.
- Bioswales are enhanced tree pits designed to capture storm water runoff, but also have cooler temperatures.

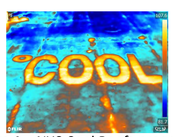

Figure 1 – NYC Cool Roofs program logo on NYPD tow pound white roof

Sponsors:
National Aeronautics and Space Administration (NASA)
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NASA New York City Research Initiative (NYCRI)
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Materials and Methods

- **FLIR T650SC** wide-angle lens
- FLIR Tools
- FLIR Research IR

- Adjust settings to environment at site
- Capture and save images
- Process data using FLIR Tools and Microsoft Excel

Figure 2 – FLIR T650SC thermal camera

Results

Roofscape

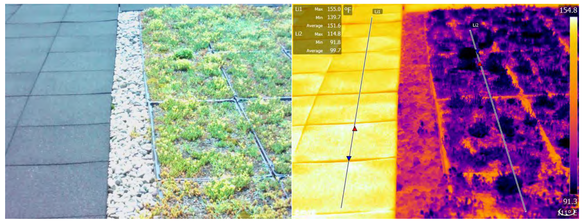

Figure 3 – Con Edison green roof with black playground mats and sedum comparison

- **Sedums** are inexpensive, drought resistant plants that are used in a majority of green roofs.
- Typical sedum roofs cost $20 and retain **10 gallons of water** per square foot (Gaffin et al. 2011)

- Black playground mat average temperature: **151.6°F**
- Sedums average temperature: **99.7°F**

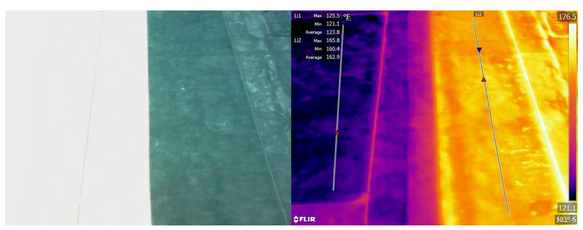

Figure 4 – Con Edison roof with white and black membrane comparison

- White membranes are **highly reflective** materials used as replacements to traditional asphalt roofs.
- White coatings are also used to cool asphalt roofs.

- White membrane average temperature: **123.8°F**
- Black membrane average temperature: **162.9°F**

Green and white roofing are much better at staying cool than black surfaces, which can reach 170°F.

Streetscape

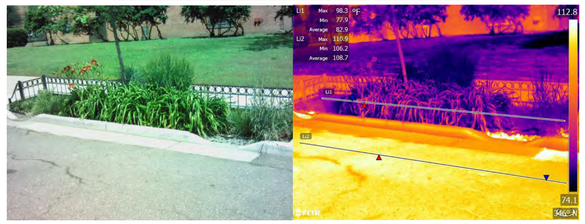

Figure 5 – Soundview Park bioswale and asphalt comparison

- Vegetated bioswales maintain a temperature that is half that of the surrounding asphalt.
- The typical bioswale costs **$13,000** with an average water retention of 1,800 gallons (Rosenblum 2012).

- Bioswale average temperature: **82.9°F**
- Asphalt average temperature: **108.7°F**

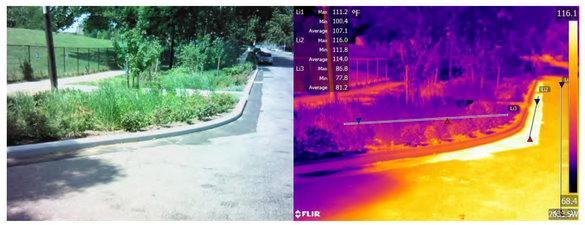

Figure 6 – Soundview Park Stormwater Green Street and asphalt comparison

- **Stormwater Green Streets** serve the same purpose as bioswales, but on a much larger scale.

- Stormwater Green Street average temperature: **81.2°F**
- Weathered asphalt average temperature: **107.1°F**
- Newer asphalt average temperature: **114.0°F**

Green Infrastructure reduces runoff, and is great at staying cool!

Future Work

- **Short Term**: Study an experimental roof with six different white membranes to see which performs best.
- **Long Term**: Further understand the capabilities of this new technology, and how it can enhance urban climate studies in the future.

Figure 7 – GAF Corp. experimental roof (Image credits courtesy of Tom Taylor)

References

Title image: https://upload.wikimedia.org/wikipedia/commons/3/39/NYC_Top_of_the_Rock_Pano.jpg
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FLIR Image: https://www.google.com/search?q=urban+heat+island+nyc&biw=1240&bih=681&source=lnms&tbm=isch&sa=X&ei=a6yeVZDSFMm4-AHIsIDwBQ&ved=0CAcQ_AUoAg#tbm=isch&q=flir+t650sc&imgrc=AAIL7NDBbbL3IM%3A
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